# ULTRIX

digital

## Technical Summary

Order Number: AA-MG63B-TE

# ULTRIX

## Technical Summary

Order Number: AA-MG63B-TE
June 1990

Product Version: ULTRIX/ULTRIX Worksystem Software Version 4.0 or higher

This document briefly describes the features of the ULTRIX operating system, including system and network functionality, documentation, services, and compatibility with other UNIX operating systems.

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maynard, massachusetts

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# Contents

## About This Document


Audience ..... vii

Organization ..... vii

Related Documentation ..... viii

Conventions ..... viii


## 1 ULTRIX Operating System Overview


1.1 Derivation of the ULTRIX Operating System ..... 1–1

1.2 Description of the ULTRIX Operating System ..... 1–2


## 2 System Facilities


2.1 General Use ..... 2–1

2.1.1 Character-Cell Terminals ..... 2–2
2.1.2 Windowing Workstations ..... 2–2
2.1.3 Printers ..... 2–2
2.1.4 Command Languages ..... 2–3

2.2 Software Development ..... 2–3

2.2.1 Programming Languages ..... 2–3
2.2.2 Associated Development Tools ..... 2–4
2.2.3 Maintenance Tools ..... 2–5
2.2.4 Compound Document Architecture Support ..... 2–5
2.2.5 SQL Support ..... 2–5
2.2.6 ULTRIX Worksystem Software Programming Environment ..... 2–5
2.2.7 Graphics and Plotting ..... 2–7

2.3 System Management ..... 2–7

2.3.1 Installation and System Generation ..... 2–7

2.3.1.1 Installation ..... 2–7
2.3.1.2 System Generation and Modification ..... 2–8

2.3.2 System Administration ..... 2–8
2.3.2.1 File Archiving ..... 2–9
2.3.2.2 ANSI-Compatible Archiving ..... 2–9
2.3.3 Maintainability ..... 2–10
2.4 Addition of Software by Users ..... 2–10

## 3 Networking Facilities

3.1 Internet Network Access ..... 3–1
3.2 DECnet Network Access ..... 3–2
3.3 Network File System and Yellow Pages ..... 3–2
3.3.1 Network File System ..... 3–3
3.3.2 Yellow Pages Service ..... 3–3
3.4 VMS/ULTRIX Connection ..... 3–3
3.5 Mail Facilities ..... 3–4
3.5.1 The ULTRIX Mail Connection ..... 3–4
3.5.2 The mail Facility ..... 3–4
3.5.3 The MH System ..... 3–4
3.5.4 The dxmail Program ..... 3–4
3.6 uucp Interfaces ..... 3–5
3.7 Local Area Transport Support ..... 3–5
3.8 Kerberos Authentication ..... 3–5

## 4 Compatibility and Industry Standards

4.1 Open Software Environments ..... 4–1
4.1.1 POSIX ..... 4–2
4.1.2 X/Open ..... 4–3
4.1.3 Open Software Foundation ..... 4–4
4.2 Network File System ..... 4–5
4.3 Berkeley BSD 4.2, 4.3, and 4.3-5 ..... 4–5
4.4 AT&T System V ..... 4–5
4.4.1 Advanced Utilities Extension ..... 4–6
4.4.2 Administered System Extension ..... 4–6
4.4.3 Software Development Extensions ..... 4–6
4.4.4 Additional System V Information ..... 4–7
4.5 UNIX V7 ..... 4–7

## 5 Hardware Requirements


5.1 Processors ..... 5–1
5.2 Memory Requirements ..... 5–1
5.3 Console Terminal ..... 5–2
5.4 System Disk ..... 5–2
5.5 Software Load Device ..... 5–2
5.6 Disk Media ..... 5–3


## 6 Documentation and Documentation Tools


6.1 Printed ULTRIX Documentation ..... 6–1
6.2 Online Documentation ..... 6–4
6.3 Documentation Development and Production ..... 6–5
6.3.1 Editors ..... 6–5
6.3.2 Processors and Formatters ..... 6–6
6.3.3 Compound Document Architecture ..... 6–6
6.3.4 Unsupported Tools ..... 6–7


## 7 Software Services


7.1 System Startup Service Packages ..... 7–1
7.2 Support Services ..... 7–1


## 8 Licensing and Ordering Information Summary

## A Software Subsets

## B Unsupported Software


B.1 Software Included with the ULTRIX Operating System ..... B–1
B.2 Software Available Through DECUS ..... B–3


## C POSIX FIPS 151-1 Modifications

## Figures

1-1: Components of the ULTRIX Operating System ..... 1–1
1-2: ULTRIX System Derivation ..... 1–2
2-1: XUI Architecture ..... 2–6
3-1: ULTRIX Networking Capabilities ..... 3–1
5-1: Minimum ULTRIX Hardware Configuration ..... 5–1

## Tables

2-1: ULTRIX Programming Languages ..... 2–4
4-1: Open Software Environments ..... 4–2
4-2: X/Open XPG2 Conformance ..... 4–3
4-3: Open Software Foundation Conformance ..... 4–4
4-4: ULTRIX Compatibility with SVID ..... 4–5
6-1: ULTRIX Document Set ..... 6–1
6-2: ULTRIX Worksystem Software Document Set ..... 6–3
6-3: Online Documentation Facilities ..... 6–4
6-4: Special-Purpose Documentation Tools ..... 6–6
A-1: Supported Software Subsets ..... A–1
A-2: Unsupported Software Subset Descriptions ..... A–3
B-1: Unsupported Software Components ..... B–1

# About This Document

This document describes Version 4.0 of the ULTRIX operating system and ULTRIX Worksystem Software (Digital Equipment Corporation's ULTRIX-based windowing workstation system). You should assume that discussion of the ULTRIX operating system applies to ULTRIX Worksystem Software as well, except where specific differences are noted.

This document applies to both the VAX and the RISC implementations of the software; differences are noted as applicable.

## Audience

This document is intended for Digital customers and others who may be considering the purchase of a UNIX system. It is directed to people who develop the technical specifications for computer system purchases. This document is also useful to owners of ULTRIX systems as a compact technical reference. You do not need to be an expert with UNIX systems to use this document.

## Organization

This document has eight chapters and three appendixes:

| | |
|---|---|
| Chapter 1 | ULTRIX Operating System Overview |
| Chapter 2 | System Facilities |
| Chapter 3 | Networking Facilities |
| Chapter 4 | Compatibility and Industry Standards |
| Chapter 5 | Hardware Requirements |
| Chapter 6 | Documentation and Documentation Tools |
| Chapter 7 | Software Services |
| Chapter 8 | Licensing and Ordering Information Summary |
| Appendix A | Software Subsets |
| Appendix B | Unsupported Software |
| Appendix C | POSIX FIPS 151-12 Modifications |

## Related Documentation

Refer to the following documents for further information about topics discussed in this manual. These documents are available from your Digital representative:

ULTRIX Software Product Description

*ULTRIX Worksystem Software Product Description*

*ULTRIX Optional Software Cross-Reference Table*

*Software Source Book, Fourth Edition*

Software Product Descriptions for optional products discussed in this document

The following documents from the ULTRIX document set contain additional related information. (The manual *R2000 Architecture* is part of the hardware documentation for RISC systems.)

*Reader's Guide and Master Index*

*Introduction to the ULTRIX Worksystem Software User Environment*

*Guide to Preparing Software for Distribution on ULTRIX Systems*

*POSIX 1003.1 Conformance Document*

*R2000 Architecture*

The Software Product Description (SPD) is the precise and legally binding definition of the software and its functionality.

## Conventions

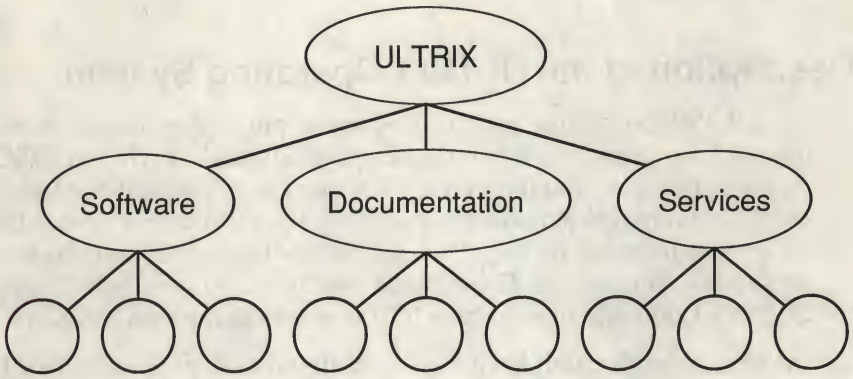
The following typographical conventions are used in this manual:

| | |
|---|---|
| `system output` | This typeface is used to indicate the exact name of a command, option, partition, pathname, directory, or file. |
| **macro** | In text, bold type is used to introduce new terms. |
| *filename* | In examples, syntax descriptions, and function definitions, italics are used to indicate variable values; and in text, to give references to other documents. |

# ULTRIX Operating System Overview 1

An operating system is a set of components that work together to provide a solution to a computing requirement. A simplified illustration of the components that make up the ULTRIX product is shown in Figure 1-1.

**Figure 1-1: Components of the ULTRIX Operating System**




The ULTRIX operating system is a native UNIX operating system for Digital Equipment Corporation's VAX and reduced instruction set (RISC) families of computers. The term **native** means that the software is written in a language that compiles either to assembly language or directly to the computer's standard machine representation (object files). Native software is more efficient and runs much faster than translated or interpreted software; in addition, it can be tailored to make the most effective use of the machine's resources.

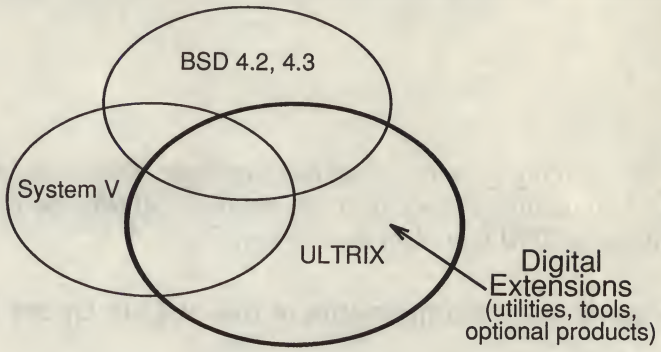
## 1.1 Derivation of the ULTRIX Operating System

Under license from AT&T, the ULTRIX software is derived from AT&T's UNIX System V, Release 2, and from the Fourth Berkeley Software Distribution, Version 4.2 (BSD 4.2), of the UNIX Timesharing System. The BSD software was developed by the Computer Systems Research Group of the Department of Electrical Engineering and Computer Science at the University of California at Berkeley.

The software also includes enhancements based on the Fourth Berkeley Software Distribution, Versions 4.3 (BSD 4.3) and 4.3-5. See Figure 1-2 for a simplified illustration of the development of the ULTRIX operating system.

The optional ULTRIX Worksystem Software component is Digital's implementation of the MIT X Window System.

**Figure 1-2: ULTRIX System Derivation**




## 1.2 Description of the ULTRIX Operating System

The ULTRIX operating system is a general-purpose, multiuser, interactive timesharing operating system that supports Digital's VAX and RISC families of 32-bit processors. Running on a VAX processor, the software has drivers for all of Digital's supported peripherals, including VAXBI devices. For RISC processors, drivers are included for all of the peripherals Digital supports on this family of processors. Support for Hierarchical Storage Subsystem (HSC) controllers and Digital's Computer Interconnect (CI) is provided for both VAX and RISC processors.

On systems with multiple CPUs, symmetrical multiprocessing (SMP) support is provided to enhance system performance.

The ULTRIX operating system includes most of the features of BSD 4.2, including a hierarchical file system with demountable volumes, compatible device and interprocess I/O, asynchronous processes, over 200 subsystems, and a high degree of portability among processors.

The ULTRIX operating system's handling of file systems is generic, such that several different types of file systems (for example, UFS and NFS) can be mounted simultaneously.

Along with the functionality of BSD 4.2, Digital has added many significant features to the ULTRIX operating system. Some of these features are source-level compatibility with AT&T UNIX System V (see Chapter 4), support for new processors and devices, new commands and programming languages (see Chapter 2), and support for Digital's Compound Document Architecture Program (see Chapter 6). Optionally, Digital's DECwindows workstation environment, ULTRIX Worksystem Software, can be added (see Chapter 2).

The ULTRIX operating system can be installed and configured without being built from source code, although source licenses are available (see Chapter 8).

Digital has further enhanced the ULTRIX product by providing enhanced and expanded documentation, both on line and in paper form.

The ULTRIX software includes extended system management and maintainability features to simplify the tasks associated with its administration.

The ULTRIX product undergoes continual enhancement. Refer to the ULTRIX and ULTRIX Worksystem Software Product Descriptions (SPD) for descriptions of features that have been added in the Version 4.0 release.

# System Facilities 2

The ULTRIX operating system provides services and facilities for the following types of activity:

- General use
  - Terminals
  - Workstations
  - Printers
  - Command languages
- Software development
  - Programming languages
  - Associated development tools
  - Maintenance tools
  - Compound Document Architecture support
  - ULTRIX Worksystem Software programming environment
  - Graphics, including traditional UNIX plotting and graphics and, on VAX processors only, GKS and ReGIS
- System management
  - Installation and system generation
  - System administration
  - Maintainability
- Addition of software by users

The following sections discuss these facilities in detail.

## 2.1 General Use

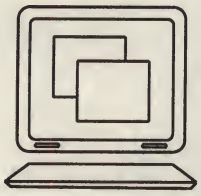
General use includes the day-to-day tasks performed by most users, including sending and receiving mail, editing files, and running applications. The ULTRIX software supports two basic user interfaces: the traditional character-cell terminal and high-resolution windowing workstations. Within each of these environments, users have access to the common UNIX command languages for communicating with the system. Additionally, workstation users have the facilities of DECwindows, Digital's windowing user environment and window management software. Spooled printing facilities are also provided. The following sections discuss these facilities.

### 2.1.1 Character-Cell Terminals

The base ULTRIX operating system supports most common hardcopy and video display terminals with either the standard UNIX V7 terminal driver or the Berkeley terminal driver. Either driver can be selected and tailored by the user with the `stty` command. Terminals of differing capabilities are supported by the `termcap` database.

The ULTRIX operating system supports the terminal extensions defined by AT&T's System V Interface Description (SVID). (See Chapter 4.)

### 2.1.2 Windowing Workstations



Color and monochrome workstations are supported by Digital's optional ULTRIX Worksystem Software. The worksystem environment implements DECwindows, Digital's X Window System offering. With its intelligent window manager, DECwindows provides a consistent user interface under both the ULTRIX and the VMS operating systems.

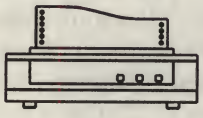
ULTRIX Worksystem Software can also be installed on a nonworkstation server system for remote use by Ethernet-connected diskless workstations by means of Digital's Diskless Management System. Client workstations need not be the same type of processor as the server; a VAX server can serve DECstations, and a DECsystem RISC server can serve VAXstations.

The worksystem environment provides **network transparent** windowing; that is, an application can run on either the user's local workstation or a remote networked machine without the user's noticing any difference. Thus, integrated systems can be implemented so that applications run where they will run most efficiently, while users interact with them on local workstations. The DECwindows implementation is optimized for the most usual case, in which the local workstation is also the application engine. DECwindows is designed to allow easy integration with various personal computer systems such as those produced by IBM and Apple.

DECwindows is an enhanced implementation of the X Window System as provided by MIT; it uses improved algorithms, exposes more interfaces, and allows greater flexibility.

DECwindows is also compatible with other industry standards, such as Adobe's PostScript page definition language. See Section 2.2.6 for a summary of worksystem programming information.

### 2.1.3 Printers



Printers of differing capabilities are supported by the `printcap` database. Printer filters are supplied for all of Digital's standard printers, including PostScript laser printers. In addition to specific filters, a universal filter and unfiltered printer access are provided through `lpf`.

ULTRIX printer support includes the standard printer control and monitoring functions provided by:

- `lpr`, the standard command to print files
- `lpd`, the printer daemon
- `lprm`, the command to remove a queued job
- `lpq`, which displays information about jobs in the printer queues

### 2.1.4 Command Languages

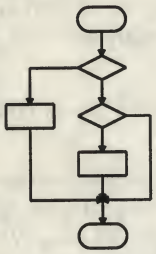
The ULTRIX operating system provides several command language interfaces, called **shells:**

- The UNIX standard Bourne shell ( `sh` )
- The C shell ( `csh` )
- The System V Bourne shell ( `sh5` )
- The Korn shell ( `ksh` )

The shells provide simple and effective use of the system's resources, including command process creation, feeding the output from one process directly into another without intermediate file manipulation (piping), and the use of standard input and output files to minimize the need for typing. Users can select the shell best suited to their needs. Because all three shells are programmable, users can further tailor features of the environment for most efficient use.

The shells also provide portability among UNIX environments. (See Chapter 4.)

## 2.2 Software Development



The ULTRIX operating system provides a broad variety of languages and tools for efficient development and maintenance throughout the phases of a software system's life cycle, including:

- Coding
- Compiling and application building
- Debugging
- Maintenance

### 2.2.1 Programming Languages

The UNIX operating system is based on the C language. The ULTRIX environment supports portable C-language programming with the traditional Kernighan/Ritchie UNIX C compiler ( `cc` ).

Also provided for VAX systems are Digital's VAX C compiler ( `vcc` ) and enhanced libraries, which together may yield significant performance gains. Similarly, programmers can use the Berkeley FORTRAN 77 ( `f77` ) compiler (optional for RISC processors) or Digital's optional VAX FORTRAN compiler ( `fort` ). VAX FORTRAN images may run faster than `f77` on a VAX system.

VAX C and VAX FORTRAN programs are source compatible between ULTRIX and VMS systems provided they contain no system-specific dependencies. Programs

written for the `cc` and `f77` compilers are compatible between ULTRIX and other UNIX systems provided they contain no system-specific dependencies.

To satisfy the needs of programmers familiar with other languages, Digital provides the language compilers listed in Table 2-1. Some of these compilers are not Digital products and are not directly supported by Digital.

In addition to the tools listed in Table 2-1, compilers and assemblers supplied by other vendors can be integrated into the ULTRIX environment. Refer to the *ULTRIX Software Source Book* for more information on vendor-supplied software.

**Table 2-1: ULTRIX Programming Languages**

| Language | Features |
|---|---|
| Lisp (`lisp`, `liszt`) | For VAX systems only, the ULTRIX operating system provides support for Lisp with the Berkeley `lisp` and `liszt` (Franz Lisp) compilers, described in the ULTRIX *Supplementary Documents, Volume II: Programmer*. |
| VAX Lisp (`vaxlisp`) optional product | The VAX Lisp compiler for the ULTRIX operating system is a full implementation of Common Lisp, except for complex numbers and the INSPECT and ED functions. VAX Lisp produces images that may run significantly faster than `lisp` images in a VAX environment. |
| Modula-2 (`mod`) | For VAX systems only, the ULTRIX operating system provides support for Modula-2 with the Berkeley `mod` compiler. |
| Pascal (`pc`) | For VAX systems only, the ULTRIX Pascal compiler supports the Berkeley Pascal implementation described in the ULTRIX *Supplementary Documents, Volume II: Programmer*. The ULTRIX operating system also provides the Berkeley standard `pi` Pascal interpreter and `pix` Pascal interpreter/executor. |
| Pascal for RISC – optional product | Digital offers an optimized, enhanced Pascal compiler for RISC systems. |
| Assemblers | For VAX systems, the ULTRIX operating system provides the Berkeley VAX/UNIX assembler as described in the ULTRIX *Supplementary Documents, Volume II: Programmer*. On RISC systems, the assembler provided is the MIPS R2000 UNIX assembler, which is described in *R2000 Architecture*. |

### 2.2.2 Associated Development Tools

Besides programming languages, the ULTRIX operating system provides a set of program development and maintenance tools, including the following:

- Debuggers:
  - `adb`, an interactive object-level debugger

    This debugger is provided for VAX systems only; for RISC systems, its features are built into an enhanced version of `dbx`.

- `ctrace`, a C program debugger
- `dbx`, an interactive symbolic debugger
- `dxdb`, a windowing debugger that is part of the ULTRIX Worksystem Software product

- Linkers and loaders:
  - `ld`, a linking loader
  - `lk`, a link editor (VAX systems only)

- Other common UNIX tools, including:
  - `awk`, a pattern scanning and matching language
  - `lex`, a lexical analysis program generator
  - `lint`, a tool for syntactic checking of C programs
  - `sed`, a stream editor
  - `yacc`, a tool that converts context-free grammars into tables useful to compilers and parsers

### 2.2.3 Maintenance Tools

The ULTRIX environment includes the following archiving and source code control tools for systematic maintenance of software:

- `ar`, a library archiver
- `make`, a tool for ensuring consistent building of applications
- `sccs`, the Source Code Control System

### 2.2.4 Compound Document Architecture Support

The ULTRIX operating system includes the Compound Document Architecture (CDA) Toolkit, a set of routines for manipulation and transport of compound document files. See Section 6.3.3 for a description of the Compound Document Architecture.

### 2.2.5 SQL Support

ULTRIX/SQL is a relational database management system with a Structured Query Language (SQL) interface. You can use ULTRIX/SQL through ULTRIX/SQL interactive utilities or with additional software, such as an ULTRIX/SQL preprocessor for application development, that you order separately.

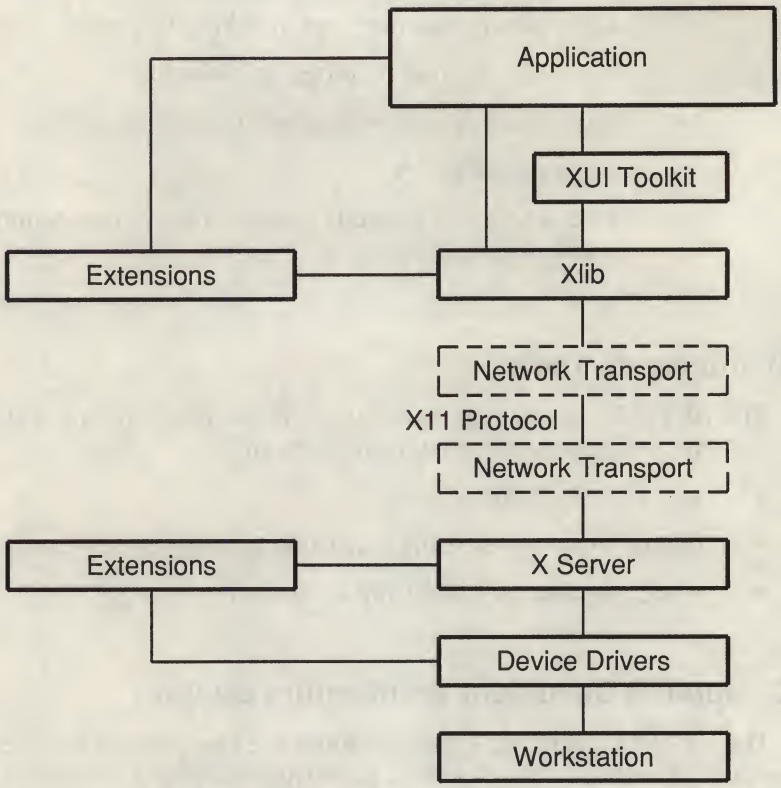
### 2.2.6 ULTRIX Worksystem Software Programming Environment

The primary component of the optional ULTRIX Worksystem Software environment is the MIT X Window System, Version 11, Release 3. The Worksystem product provides a programming interface (XUI, the X User Interface) to application programs that is device independent and network transparent. Applications designed to the X standards can run unchanged on any host with TCP or DECnet connection

capability between the application host and the system hosting the X server. The X server need not be the same type of hardware as the client; for example, a VAX X server can serve DECstation clients, and a DECsystem server can serve VAXstation clients. For increased portability, DECwindows applications are compatible between ULTRIX and VMS systems.

The overall architecture of Digital's XUI is shown in Figure 2-1. Applications can call on services at whatever level of abstraction is required for the most effective implementation.

**Figure 2-1: XUI Architecture**




The X server provides capabilities to manage windows and provide graphics and text output through a window.

The ULTRIX Worksystem Software product includes the following additional features:

- The DECwindows window manager (`dxwm`)

  The window manager is a complete user environment that allows the user to manipulate window applications by moving, resizing, restacking, and circulating windows, as well as shrinking windows to icons and restoring them.

- XUI Toolkit programming libraries

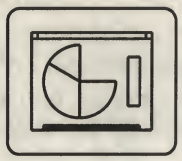
  These libraries, a widget library and an intrinsics library (building blocks for constructing widgets), are Digital-implemented supersets of the X Toolkit libraries, providing major enhancements over the standard X11 libraries. They are shared with the VMS implementation of DECwindows, to provide application portability.

- A set of bundled applications including a calendar, cardfiler, clock, notepad, paint graphics editor, and others

The DECwindows software also includes extensions to the X11 protocol provided by Display PostScript:

- A server extension that executes PostScript graphics descriptions and can display the results in an X Drawable
- An extension to the client X interface library, Xlib
- A run-time library of higher-level PostScript functions
- A facility called `pswrap` that allows programmers to write PostScript programs, convert them into C programs, and call them from other C modules
- A PostScript Previewer application that displays documents written in PostScript in a workstation window using the PostScript extension.

### 2.2.7 Graphics and Plotting



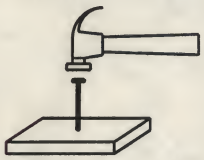
In addition to the graphic capabilities provided by ULTRIX Worksystem Software, the ULTRIX operating system supports the standard UNIX V7 plot library, accessed through the `plot` filter command. The `plot` command has been enhanced to support Digital devices, including terminals using the DEC_CRT2 and DEC_CRT3 supersets of the ANSI protocol, dot-matrix printers, and ReGIS graphics output devices.

As an optional product, Digital offers a subroutine library to support the ISO/ANSI standard Graphical Kernel System (GKS) graphics language at Level 2b. Level 2b provides all GKS functionality except Sample and Event input.

## 2.3 System Management

The ULTRIX environment includes an extended set of tools and services for effective system management. These tools ease many of a system manager's tasks, from initial installation through day-to-day maintenance and occasional crash recovery.

### 2.3.1 Installation and System Generation



The ULTRIX operating system includes enhanced facilities for installation and operating system generation.

The distribution kit is segmented into a base ULTRIX system, which is always loaded, and optional software segments (called subsets). See Appendix A for a list of software subsets.

**2.3.1.1 Installation –** It is not necessary to build the ULTRIX operating system from sources; subsets contain executable programs and linkable object modules.

Most of the software installation is highly automated. Software subsets are loaded automatically with the `setld` utility program. The `setld` utility loads, unloads, and

inventories subsets. For installing subsets, the `setld` utility displays a list of the subsets available to be installed; the system administrator can select any or all for installation. The utility can also execute the Installation Verification Programs (IVPs) for products that have them.

Installation can be made from any supported distribution media to any supported system disk. Users can also install software over a network by using the Remote Installation Services (`ris`).

For installations on standalone systems without tape devices, distribution kits can be first be installed from any supported media to a system with a removable-media system disk. The removable-media system disk containing the installation can then be moved to the standalone system, as long as the system disk media is identical on both systems.

VAX systems connected to common disks through one of Digital's Hierarchical Storage Controller (CI/HSC) systems can share the disks for installation purposes.

Distribution media supported for DECstation and DECsystem RISC processors are Digital's Compactape cartridge tape, reel-to-reel tape, and CDROM compact discs.

**2.3.1.2 System Generation and Modification –** Operating system generation is handled by a kernel generation program called `doconfig`. System generation is interactive and performs functions such as configuration of devices and optional operating system features, specification of kernel size and tuning parameters, and automated kernel building. The `doconfig` program provides online help for these functions.

Exerciser programs for system testing and verification are located in the `/usr/field` disk area.

Changing system setup in response to configuration changes is convenient. For example, administrators can set up printer spoolers using an interactive tool called `lprsetup`, which has online help and provides default answers to questions about modifying the system's printer setup. The `uucp` facility setup uses a similar tool called `uucpsetup`. Local area network setup uses `netsetup`. These tools, and others, avoid the need for direct editing of terminal, printer, or network control files.

### 2.3.2 System Administration

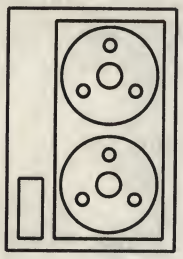
The ULTRIX operating system includes the following system administration facilities:

- An operator service utility, `opser`, which helps the system operator to perform administrative functions such as system startup and shutdown, file system backups, and file system consistency checks
- A printer control utility, `lpc`, which enables the system administrator to monitor, start, and stop printer queues
- File system creation and maintenance utilities:
  - `mkfs` and `newfs` for creating file systems
  - `mount` and `umount` for mounting and unmounting file systems
  - `fsck`, `dcheck`, and `ncheck` for checking file system integrity

- dump and restore for backing up and restoring file systems
- du, df, and quot for monitoring file system usage

- General system monitoring utilities:
  - cpustat for monitoring CPU usage
  - iostat for monitoring disk and CPU usage
  - vmstat for monitoring memory usage
  - nfsstat for displaying NFS statistics
  - ipcs for reporting IPC facilities status
  - lpstat for monitoring printer status
  - ps and pstat for monitoring process and system status
  - arp, ifconfig, netstat, ruptime, and rwho for monitoring TCP/IP network status
  - ac, accton, and sa for monitoring login and system accounting
- CPU control utilities:
  - startcpu for starting a secondary processor
  - stopcpu for stopping a secondary processor
- An automatic remote distribution system, rdist, that automatically updates an administrator-specified list of files across a network at selected intervals

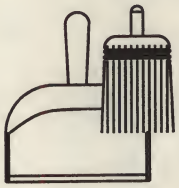
**2.3.2.1 File Archiving –** The tar and cpio utilities save and restore individual files or selected directory subtrees using magnetic tape or, on VAX systems, floppy disks. In addition, the tar utility saves and restores empty directories and special files, and supports multivolume archives.



The ULTRIX tar utility supports the POSIX-specified USTAR format.

**2.3.2.2 ANSI-Compatible Archiving –** The Labeled Tape Facility ( ltf ) is similar to the tar utility. However, it writes and reads tape volumes using formats that are compatible with ANSI Versions 3 and 4, thereby permitting information exchange with VMS systems and other operating systems whose tape formats comply with the ANSI standards. The ltf utility restricts block sizes to 2048 bytes for writes and 10240 bytes for reads.

### 2.3.3 Maintainability



The ULTRIX operating system kernel is enhanced to provide recovery from many hardware error conditions. The software includes the following maintainability enhancements to ease the system administrator's job for tasks such as error logging and crash recovery:

- A device and memory error logging system, including:
  - Kernel and device driver error-gathering scripts
  - `elcsd` daemon for error logging
  - `eli` command for error logging housekeeping
  - `uerf` error log report generator
- A crash dump facility that can write a crash dump to disk or tape
- Disk media error support services, including the ability to statically replace bad blocks and, on VAX systems, drivers that dynamically replace bad blocks
- Standalone initialization and verification programs

## 2.4 Addition of Software by Users

Users, vendors, and others producing software for addition to the ULTRIX operating system can produce kits using the same tool set used by Digital to build the ULTRIX distribution kit. The tools can be used to add to, subtract from, or modify the contents of product kits. Documentation is provided that describes how to use the `setld` utility and kit-building tools to install and maintain user-created software.

Designing kits to use the `setld` utility ensures the following:

- Installation security

  Each subset is verified immediately after transfer and is recoverable for reinstallation or in case of damage or deletion.

- Flexibility

  You can use the `setld` utility to choose subsets at installation, and to delete and later reinstall subsets.

- Uniformity

  The `setld` utility is an integral part of the ULTRIX installation architecture. Producing kits that are compatible with the `setld` utility ensures compatibility with future installations. In addition, `setld`-compatible kits can be installed on a server machine for network installation with the `ris` utility.

- Media support

  Kits can be built on any device supported by the `setld` utility.

- Binary- or source-level distribution

  Kits can be built containing source code, linkable object files, or binary images.

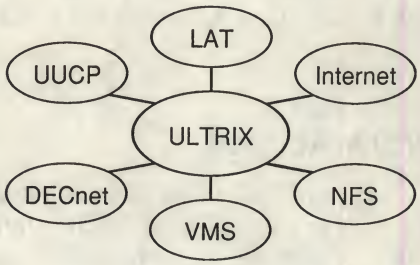
- Documentation

  The `setld` utility is described in Section 8 of the *ULTRIX Reference Pages*. The tools for building `setld`-compatible kits are discussed in the *Guide to Preparing Software for Distribution on ULTRIX Systems*.

# Networking Facilities 3

The ULTRIX operating system provides the general networking capabilities shown in Figure 3-1.

**Figure 3-1: ULTRIX Networking Capabilities**

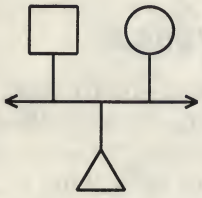



These networking capabilities are provided by the following general facilities:

- Internet network access
- DECnet network access
- VMS/ULTRIX Connection
- Mail facilities
- The `uucp` facility
- Network File System (NFS) and Yellow Pages (YP)
- Local Area Transport (LAT) support
- Kerberos authentication

The following sections discuss these facilities in detail.

## 3.1 Internet Network Access



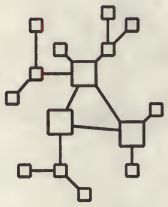
The ULTRIX operating system supports Internet communications using the Transmission Control Protocol/Internet Protocol (TCP/IP) and User Datagram Protocol/Internet Protocol (UDP/IP) over an Ethernet Local Area Network (LAN). This support facilitates mail, file transfer, remote execution, and remote login capabilities. Supported commands include `ftp`, `rcp`, `rlogin`, `rsh`, `ruptime`, `rwho`, `sendmail`, `talk`, `telnet`, and `tftp`.

The ULTRIX software supports the FTP, TFTP, Telnet, and SMTP Internet services.

The Berkeley Internet Name Domain (BIND) service is a high-performance host name and address lookup system for networked systems using the Internet protocol. The ULTRIX BIND service is based on Berkeley's BSD 4.7.3 version of BIND, with Digital enhancements. The BIND service caches the host name-address information it gets and thus can increase throughput over systems not using caching techniques, and it eliminates the need for a central clearinghouse for the information.

The ULTRIX operating system includes an SNMP (Simple Network Management Protocol) Agent which allows an ULTRIX host to be managed by a network manager. SNMP is the Internet standard protocol for exchanging network management information. The SNMP Agent provides a local or remote network manager with system information, network interface data, address resolution information (ARP), information about the routing layer (IP and ICMP), and information about the transport layer (TCP and UDP). The ULTRIX operating system also provides a programming interface for a user-written Extended SNMP Agent to provide management information for objects that are not part of the Internet standard.

## 3.2 DECnet Network Access



DECnet software is an optional product for the ULTRIX operating system. The Digital Network Architecture (DNA) provides communication across a heterogeneous network. A DECnet network is organized into a decentralized tree-like structure containing up to 63 areas, each of which can contain as many as 1023 processor nodes.

Traffic within and between areas is managed by independent routing nodes so that end nodes need not know the explicit routing to other nodes they communicate with.

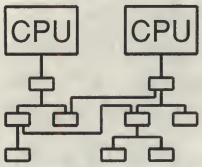
The ULTRIX operating system runs the DECnet protocol as an end node and serves as a gateway from ULTRIX and UNIX systems to systems in a DECnet network. The DECnet access facility includes:

- Electronic mail
- Remote login in both directions
- File transfer in both directions, commanded from either end

Supported DECnet commands are `dcat`, `dcp`, `dlogin`, `dls`, `drm`, and `mail`.

The use of wildcards is supported for file transfer operations, and file names are generated automatically on the target system if not specified explicitly.

## 3.3 Network File System and Yellow Pages




Under license from Sun Microsystems, the ULTRIX operating system includes the Sun Network File System (NFS), Yellow Pages, lock manager, and status monitor. These facilities are designed to promote resource sharing by making information available to multiple systems connected by an Ethernet LAN.

### 3.3.1 Network File System

NFS permits file sharing among physically separate systems connected by an Ethernet. A processor can export file systems to, or import file systems from, other processors running NFS.

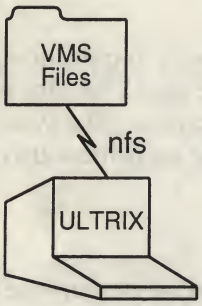
Exporting file systems consists of making available a file that lists directories that systems have permission to access, together with the parameters controlling access. Controlling parameters include the names of clients that are permitted access, and access permissions on the files within the exported file systems. The exporting system, or server, plays a passive role in the file sharing.

A processor that imports file systems, called a client, can mount those file systems at any desired point within its local file system. Imported file systems are not copied to the client's own file systems but are accessed transparently by the use of remote procedure calls. Imported file systems appear to a user of the client system as nodes in the client's local file system.

### 3.3.2 Yellow Pages Service

The Yellow Pages service (YP) implements common databases for information such as user names and passwords, network domains, and so forth. These databases are shared among the systems in a network, allowing users to log in to any participating system with full access to their own files. The service is implemented so that a single system is the YP server at any given time; if that system fails, another system takes over the server function.

## 3.4 VMS/ULTRIX Connection

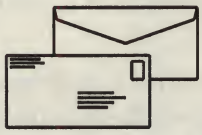



The VMS/ULTRIX Connection is an optional product for Digital's proprietary VMS operating system. It is a Digital extension that promotes resource sharing between NFS workstation clients running the ULTRIX operating system or other UNIX implementations and one or more servers running the VMS operating system. The server can be one host, a VAXcluster system, or specific members of a VAXcluster system. The clients are connected to the server by an Ethernet LAN. The VMS/ULTRIX Connection software resides entirely on the VMS system.

The VMS/ULTRIX Connection provides transparent access from the ULTRIX clients to RMS STREAM_LF files located on the VMS server. RMS is Digital's Record Management System, one of the file structures used on VMS systems; STREAM_LF is one sequential record format for RMS files. Files on the host appear to the clients as BSD standard files and can be manipulated as if they were local to the client.

In addition to NFS file access, the VMS/ULTRIX Connection allows the VMS system to support many TCP/IP networking utilities, such as `telnet` and `rlogin`.

## 3.5 Mail Facilities



The ULTRIX system provides extended mail facilities. In addition to Internet and `uucp` mailing services, the ULTRIX Mail Connection allows interchange between ULTRIX and the VMS MAILbus and with gateways into other mail networks. On a workstation, the DECwindows interface to mail (`dxmail`) provides an integrated environment for transferring, editing, and filing messages. Incoming and outgoing messages are directed to an appropriate network or addressee by the message transfer agent `sendmail`.

### 3.5.1 The ULTRIX Mail Connection

The ULTRIX Mail Connection is an optional product providing enhanced mail services on the ULTRIX operating system. It contains an enhanced version of the user agent MH and is a gateway between ULTRIX sendmail and the VAX Message Router (MAILbus), providing mail exchange with ALL-IN-1, X.400, IBM's PROFS or SNADS, and Telex. The ULTRIX Mail Connection includes the following additional function:

- Converts WPS-PLUS files from ALL-IN-1, as well as DECdx files from IBM users, into ASCII text.
- Provides an address look-up facility, allowing users to look up mail addresses in the Message Router Directory Services database (DDS).
- Supports sending/receiving complex nested messages and CDA files.

### 3.5.2 The mail Facility

The `mail` facility is derived from the BSD. It allows users to transmit and receive text files in single-node or multinode environments. The `mail` facility supports distribution lists, aliases, and message forwarding instructions. The system also provides notification of new mail either synchronously or asynchronously.

### 3.5.3 The MH System

The optional Rand MH system is a set of small, powerful single-purpose command programs for sending, receiving and manipulating mail. Users may choose an editor or use the one provided. MH supports distribution lists, aliases, filing and retrieval of mail in customizable folders, the transfer of CDA files and mail notification. (See Section 6.3.3 for a description of CDA.) Unlike the closed environment of `mail` MH allows users to intersperse mail-handling commands freely among other shell commands.

### 3.5.4 The dxmail Program

The `dxmail` program is an intelligent windowing mail handler that is part of the optional ULTRIX Worksystem Software product. Installation of the MH system (described in Section 3.5.3) is a prerequisite to using `dxmail`.

## 3.6 uucp Interfaces

The `uucp` facility is a series of programs that permit communication between ULTRIX systems or any UNIX `uucp` systems using the standard G protocol. Files can be transferred and remote commands can be executed over dialup or hardwired communication lines. Files transferred in this manner are created in a spool directory for processing by the `uucp` daemons. If the transfer includes executable commands, the commands are executed in batch mode and the command, data, and work files are deleted from the spool directory.

The `uucp` facility supports all of Digital's currently supported autodialing modems.

The `tip` utility establishes a full-duplex connection to another system, providing virtual terminal access to the remote system. The `tip` utility also provides ASCII file transfer.

## 3.7 Local Area Transport Support

The ULTRIX operating system's Ethernet support includes Digital's Local Area Transport (LAT) protocol for terminal connection through DECserver terminal concentrators. LAT service is activated and controlled by the `lcp` utility.

DECservers provide a means to connect many terminals or dialup modems to several different systems on an Ethernet LAN, serving as a transparent link between a given terminal and one or more systems to which the terminal can be connected simultaneously. The user can switch from one session to another by issuing commands to the DECserver.

Serial printers can also be connected to a DECserver, allowing printer use by all the systems recognized by the DECserver.

## 3.8 Kerberos Authentication

In a networked environment with communicating applications on many machines, authentication through the standard login procedures provides inadequate security. Kerberos is an authentication service offered with the ULTRIX operating system to serve as a single point of trust in a local area network (LAN). Kerberos does not function in a single-system environment or across wide area networks.

Kerberos authenticates applications to each other across machine boundaries in a distributed network. In Kerberos, the communicating entities are called principals. The application that requests that an application on another machine be performed on its behalf is called a client. The requested application is called a server application or a service. ULTRIX Kerberos supports the authentication of commonly networked applications, such as `named` and `auditd`.

# Compatibility and Industry Standards 4

The ULTRIX operating system is compatible with other UNIX software system implementations and with several industry standards. This chapter outlines this compatibility with the following systems and standards:

- Open software environments
  - POSIX
  - X/Open
  - Open Software Foundation (OSF)
- Network File System (NFS)
- Berkeley Standard Distribution (BSD)
- AT&T System V
- UNIX V7

Specific implementation or standards information in this chapter is presented in the same order as in the corresponding standards documents.

Application portability between UNIX systems can best be achieved through applications that conform to the POSIX, OSF, and X/Open specifications. Compatibility with BSD, System V, and UNIX V7 is provided for access to existing applications; development of new applications based on functionality that is unique to specific system implementations is discouraged.

**Note**

In this document the words **conformance** and **compliance** are used as defined in the POSIX 1003.3 standard. Conformance is defined as satisfaction of all requirements of a given specification. Compliance is defined as satisfaction of all *measurable* requirements of a given specification. Compliance is a subset of conformance.

## 4.1 Open Software Environments

The ULTRIX operating system is a product of Digital's commitment to the concept of open software environments. Table 4-1 illustrates ULTRIX compliance with POSIX, X/Open, and OSF standards. Specifics of this compliance are further discussed in Sections 4.1.1 to 4.1.3.

**Table 4-1: Open Software Environments**

| Environment | Function | Environment Components |
|---|---|---|
| NIST Applications Portability Profile | Data management | SQL, IRDS |
| | Languages | C, COBOL, FORTRAN, Ada, Pascal (COBOL and Ada on VAX only) |
| | User interface/graphics | X Window System, GKS, CGM, IGES |
| | Operating system | IEEE STD 1003.1-1988 (POSIX) and FIPS 151-1 |
| | Network services | NFS |
| | Data interchange | SGML, ODA/ODIF |
| POSIX | System interface | IEEE STD 1003.1-1988 (POSIX) and FIPS 151-1 |
| X/Open | Data management | ISAM, ANSI SQL |
| | Languages | ANSI C, ISO Pascal, ANSI FORTRAN 77, ANSI COBOL 85, Ada (COBOL and Ada on VAX only) |
| | User interface/graphics | X Window System |
| | Operating system | IEEE STD 1003.1-1988 and FIPS 151-1 plus 8-bit transparent commands |
| | Network services | XTI |
| OSF Level 0 | Data management | ANSI SQL Level 2 |
| | Languages | C, FORTRAN, Pascal, Ada, COBOL, BASIC, Common Lisp (Ada, COBOL, BASIC, and Lisp on VAX only) |
| | User interface/graphics | X Window System, GKS, PHIGS |
| | Operating system | POSIX 1003.1-1988 and FIPS 151-1, X/Open Base Level |
| | Network services and applications | TCP/IP (SMTP, FTP, Telnet) |

### 4.1.1 POSIX

The ULTRIX operating system is fully conformant with the IEEE Standard 1003.1-1988 Portable Operating System for Computer Environments (POSIX) specification, including the extended specifications of the POSIX Federal Information Processing Standard (FIPS 151-1).

When certification based on the National Institute for Standards and Technology's POSIX Conformance Test Suite (PCTS) becomes available, the ULTRIX operating system will be verified by an independent testing organization as a POSIX-compliant implementation and as compliant with the POSIX FIPS.

Refer to Digital's *POSIX 1003.1 Conformance Document* for Digital's official statement of conformance. Refer to IEEE Standard 1003.1-1988 for POSIX conformance specifics. See Appendix C for a list of federally specified POSIX amendments to which the ULTRIX operating system conforms.

### 4.1.2 X/Open

The ULTRIX operating system is conformant with the base level specification of the X/Open Common Applications Environment. Except as noted in Table 4-2, the ULTRIX operating system environment provides full conformance with the full Common Applications Environment, as defined by X/Open Portability Guide 2 (XPG2).

**Table 4-2: X/Open XPG2 Conformance**

| Component | Support |
|---|---|
| System calls and libraries | Included |
| Commands and utilities | Included |
| C language | Included |
| COBOL language | Third party (VAX only) |
| Pascal language | Not available |
| FORTRAN language | Optional Digital product |
| ISAM | Third party (VAX only) |
| SQL | Third party (VAX only) |
| Eight-bit transparency (see below) | Included |
| Terminal interfaces | Included |
| Window manager | Optional, part of ULTRIX Worksystem Software product |
| Interprocess communication | Included |
| Source code transfer | Included |
| Transport interface | Included |
| PC interworking | Third party |

To support XPG3 8-bit transparency requirements, the ULTRIX operating system includes the following 8-bit clean commands:

| | | | | | |
|---|---|---|---|---|---|
| adduser | date | iconv | pr | tar | uupick |
| ar | diff | kill | ps | tee | uustat |
| awk | echo | ksh | pwd | test | uuto |
| cat | ed | lex | red | tip | uux |
| cc | egrep | ln | rlogin | tr | vi |
| cd | emacs | login | rm | true | wait |
| chgrp | ex | lp | rmdir | tty | wc |
| chmod | expr | ls | sed | umask | which |
| chown | false | mkdir | sed | uname | who |
| cmp | fgrep | more | sh5 | uniq | yacc |
| comm | find | mv | sleep | unpack | |
| cp | gencat | pack | sort5 | uucp | |
| cpio | grep | pcat | stty | uulog | |
| csh | head | pg | tail | uuname | |

### 4.1.3 Open Software Foundation

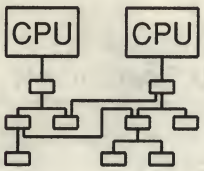
*Open Software*
FOUNDATION

The ULTRIX operating system meets the Open Software Foundation (OSF) Level 0 Application Environment Specification (AES) for the operating system. Except as noted in Table 4-3, the ULTRIX operating system environment conforms with OSF level 0.

**Table 4-3: Open Software Foundation Conformance**

| Component | Detail | Support |
|---|---|---|
| Operating system | POSIX standards: ANSI, ISO, FIPS | Included |
| | X/Open XPG 3, base level | Included |
| Languages | C: ANSI X3J11 | Included |
| | FORTRAN: ANSI X3.9-1978; ISO 1539-1980(e); FIPS 069-1 | Included (VAX), Optional product (RISC) |
| | Pascal: ANSI X3J9, ISO 7185-1983, FIPS 109 | VAX only |
| | Ada | Third Party (VAX) |
| | BASIC | Optional product (VAX) |
| | COBOL | Third party (VAX) |
| | LISP: Common LISP, ANSI X3J13 | Optional product (VAX) |
| User interface/ window manager | X Window System, V. 11, ANSI X3H3 | Included |
| | X language bindings, ANSI X3H3 | Included |
| Graphics libraries | GKS, ANSI X3.124-1985, FIPS 120 | Included (VAX) |
| | PHIGS, ANSI X3H3.1 | Optional product (VAX) |
| Networking services | TCP (MIL-STD-1778) | Included |
| | IP (MIL-STD-1777) | Included |
| | SMTP (MIL-STD-1781) | Included |
| | Telnet (MIL-STD-1782) | Included |
| | FTP (MIL-STD-1780) | Included |
| Database management | SQL | Third party |

## 4.2 Network File System




The ULTRIX operating system includes licensed, fully conformant support for the Sun Microsystems Network File System (NFS), Mount, Yellow Pages, lock manager, and status monitor. These services have been tested and found compatible with the corresponding services in SunOS Versions 3.0, 3.2, 3.4, and 4.0.

## 4.3 Berkeley BSD 4.2, 4.3, and 4.3-5

Because the ULTRIX operating system is based on BSD 4.2 with enhancements from BSD 4.3 and 4.3-5, there is a high degree of compatibility between these systems:

- For VAX systems with removable disks, file system formats are interchangeable provided disk partitions are compatible.
- Shell script syntax is highly compatible in both the C shell and the Bourne shell.
- The ULTRIX C language and run-time libraries are fully compatible with the corresponding BSD 4.2 libraries.
- The ULTRIX BIND service is fully compatible with Berkeley BIND Version 4.7.3.

## 4.4 AT&T System V

The ULTRIX operating system is compatible at the source code level with AT&T's System V Interface Definition (SVID). Source-level portability allows application programs written for the System V programming environment to run after being compiled and linked on an ULTRIX system. The ULTRIX software's compatibility with System V is based on SVID Issue 2. The degree of compliance with the SVID is listed in Table 4-4. Where the ULTRIX operating system is not fully compliant with System V, the differences are described in Sections 4.4.1 to 4.4.4.

**Table 4-4: ULTRIX Compatibility with SVID**

| Volume 1, Part II, Base System | |
|---|---|
| **Interface Definition Description** | **ULTRIX Compatibility** |
| Operating system services | Full |
| Error conditions | Full |
| Signals | Full |
| Other library routines | Full |
| Header files | Full |
| Environment variables | Full |
| System-resident data files | Full |
| Directory tree structure | Full |

**Table 4-4: (continued)**

| Volume 1, Part III | |
|---|---|
| **Interface Definition Description** | **ULTRIX Compatibility** |
| Kernel extensions | Full |

| Volume 2, Parts II, III, IV, V, and VI | |
|---|---|
| **Interface Definition Description** | **ULTRIX Compatibility** |
| Base utilities extension | Full |
| Advanced utilities extension | Partial (see Section 4.4.1) |
| Administered system extension | Partial (see Section 4.4.2) |
| Software development extension | Partial (see Section 4.4.3) |
| Terminal interface extension | Full |

### 4.4.1 Advanced Utilities Extension

The ULTRIX operating system provides 33 of the 42 utilities and functions described in Volume 2, Part III of the SVID, Issue 2. The following utilities are not included:

```
cancel (lp)   lpstat   shl
dircmp        mailx    uuto
logname       news
```

The `cancel`, `lpstat`, `mailx`, and `uuto` utilities are excluded because they conflict with existing BSD-based ULTRIX utilities performing the same or similar functions.

### 4.4.2 Administered System Extension

Only the following Administered System Extension commands and utilities are included in the ULTRIX software:

```
accton   ipcs     nice
clri     mkfs     sync
fsck     mknod    umount
init     mount
ipcrm    ncheck
```

### 4.4.3 Software Development Extensions

The `env` and `sdb` utilities and the `libg` library are not included in the ULTRIX software. The `libld` library is included for RISC systems but not for VAX systems.

### 4.4.4 Additional System V Information

In addition to the utilities, functions, and libraries listed in Sections 4.4.1 to 4.4.3, this section describes issues of compatibility between the System V and ULTRIX environments:

- File systems are not compatible. The ULTRIX operating system uses the BSD Fast file system structure.
- Bourne shell scripts are syntax compatible, and are fully compatible if `sh5`, the System V shell, is used on the ULTRIX system.
- C source code programs are compatible if they include no hardware architectural dependencies.
- The System V `open` system call can be invoked with a null pathname. As required by the POSIX FIPS, the ULTRIX `open` system call returns an error if invoked with a null pathname.
- The System V `chown` system call can be invoked by any user. As required by the POSIX FIPS, the ULTRIX `chown` call is restricted to the superuser.
- System V truncates a too-long pathname without notification. As required by the POSIX FIPS, the ULTRIX operating system returns an error if the _POSIX_NO_TRUNCATE environment variable specifies no truncation.

## 4.5 UNIX V7

The ULTRIX operating system is derived from BSD 4.2 and BSD 4.3, which are in turn derived from the UNIX V7 system. Because of this derivation, the ULTRIX operating system is highly compatible with UNIX V7. Except for the features listed here, all features of the UNIX V7 system are included and are compatible:

- Linking of V7 objects is not compatible; that is, removable disk media are not interchangeable.
- The following UNIX V7 features are not included in the ULTRIX operating system:
  - The BASIC interpreter (`bas`)
  - The packet driver and simulator (`pkopen`)
  - Multiplexed files
  - Source files for UNIX documents in `nroff` format (`/usr/doc`)
  - DC11, TC11, RF11, and RS03/04 device drivers
  - The encryption/decryption routine (`crypt`)

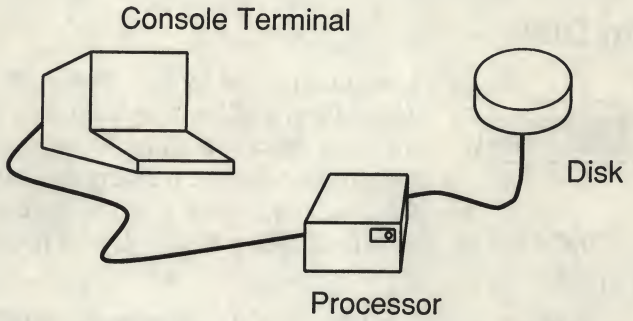
    No form of encryption or decryption is included except the one-way password encryption algorithm. The `crypt` routine is included in Digital's optional ULTRIX Encryption product, which provides encryption facilities conforming to the National Bureau of Standards Data Encryption Standard (DES). This optional product is available for customers in the USA and Canada only.

# Hardware Requirements 5

This chapter describes the minimum hardware needed to run the ULTRIX operating system. Refer to the ULTRIX Software Product Description (SPD) for a complete listing of maximum configurations and supported hardware.

The minimum configuration required to run the ULTRIX operating system is a processor with memory, a console terminal, and a system disk, as shown in Figure 5-1.

**Figure 5-1: Minimum ULTRIX Hardware Configuration**




An Ethernet network connection can be substituted for the system disk.

## 5.1 Processors

The ULTRIX operating system is fully supported on most VAX processors, including MicroVAX, VAX, VAXserver, and VAXstation processors. ULTRIX Worksystem Software is fully supported on all DECstation and DECsystem RISC processors. For a current list of supported processors, refer to the ULTRIX SPD.

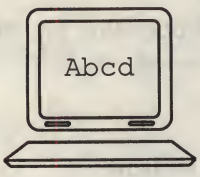
## 5.2 Memory Requirements

The following table illustrates the memory requirements for the ULTRIX operating system:

| Processor Type | Minimum Memory |
|---|---|
| All multiuser (nonworkstation) VAX processors except the VAX 3500 and VAX 3600 | 5 megabytes |
| All VAXstations except the VAXstation 3500 and VAXstation 3600 | 6 megabytes |

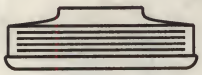
| Processor Type | Minimum Memory |
|---|---|
| VAX 3500, VAX 3600, VAXstation 3500, and VAXstation 3600 | 8 megabytes |
| All DECsystem and DECstation RISC processors | 8 megabytes |

## 5.3 Console Terminal




One ASCII console terminal is required. On a VAXstation or a DECstation, the console terminal can be the workstation's screen. Terminals that do not accept lowercase characters are not supported as the console terminal. VT200-series and newer terminals must be operated in VT100 emulation mode.

## 5.4 System Disk



In addition to the system disk space required for the root and `/usr` files, additional system disk storage must be allocated for swap space, based on memory size. Generally, swap space should be twice the memory size for multiuser systems, and three times memory size for servers and workstations. On some RISC systems, the default disk partition layout provides the correct amount of swap space.

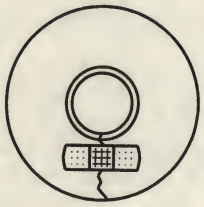
System support is provided for all disk adapters and devices that communicate using Digital's Mass Storage Control Protocol (MSCP), for some UNIBUS disks, and for some Small Computer System Interface (SCSI) disks. Not all supported disks are large enough to store the root and `/usr` files with sufficient space remaining for swap space; refer to the ULTRIX SPD for a list of disks that can be used as system disks.

All the optional subsets included with the ULTRIX kit require approximately 100Mb of disk storage, but this space need not be on the system disk.

## 5.5 Software Load Device

The ULTRIX software can be loaded from standard 1600 bpi 9-track reel-to-reel tapes, Digital's Compactape cartridge devices, or CDROM. Additionally, for VAX systems, the software can be loaded from certain disk devices. Refer to the ULTRIX SPD for a complete list of supported software load devices.

## 5.6 Disk Media



Traditionally, UNIX operating systems require all disk media to be completely free of hard errors. Most implementations tolerate soft errors. The ULTRIX software supports bad block replacement and verification for hard errors on most of the larger disks. In most cases, this support eliminates the need for error-free media.

# Documentation and Documentation Tools 6

The ULTRIX operating system includes a comprehensive set of documentation, both online and in printed form. Also included is a broad set of document preparation tools.

## 6.1 Printed ULTRIX Documentation

Documentation for the ULTRIX operating system includes a broad variety of manuals and user guides, designed to simplify locating and using the information they contain. Table 6-1 describes the complete ULTRIX document set for timesharing systems; Table 6-2 describes the complete ULTRIX Worksystem Software document set.

**Table 6-1: ULTRIX Document Set**

| Document Volume | Contents |
|---|---|
| ULTRIX General Information Kit, Volume 1 | Technical Summary Reader's Guide and Master Index |
| | Unsupported Reference Pages |
| ULTRIX General Information Kit, Volume 2 | The Little Gray Book: An ULTRIX Primer |
| | The Big Gray Book: The Next Step with ULTRIX |
| | Guide to the nawk Utility |
| | Security Guide for Users |
| | Reference Pages Section 7:Macro Packages and Conventions |
| ULTRIX General Information Kit, Volume 3A | Reference Pages Section 1: Commands A – L |
| ULTRIX General Information Kit, Volume 3B | Reference Pages Section 1: Commands M – Z |
| ULTRIX System and Network Management Kit, Volume 1 | Guide to Software Licensing |
| | Guide to System Environment Setup |
| | Guide to System and Network Setup |
| | Guide to the Location Broker |
| | Security Guide for Administrators |
| | Guide to PrintServer Clients |

**Table 6-1: (continued)**

| Document Volume | Contents |
|---|---|
| ULTRIX System and Network Management Kit, Volume 2 | Guide to Configuration File Maintenance |
| | Guide to Shutdown and Startup |
| | Guide to Backup and Restore |
| | Guide to Disk Maintenance |
| ULTRIX System and Network Management Kit, Volume 3 | Guide to System Crash Recovery |
| | Guide to the Error Logger |
| | Guide to System Exercisers |
| | Kernel Messages Reference Manual |
| ULTRIX System and Network Management Kit, Volume 4 | Introduction to Networking and Distributed System Services |
| | Guide to Ethernet Communications Servers |
| | Guide to the Network File System |
| | Guide to the BIND/Hesiod Service |
| | Guide to the Yellow Pages Service |
| | Guide to Kerberos |
| | Guide to the uucp Utility |
| | Guide to IBM Terminal Emulation for VAX Processors |
| ULTRIX System and Network Management Kit, Volume 5 | Guide to Server Setup |
| | Guide to Diskless Management Services |
| | Guide to Remote Installation Services |
| ULTRIX System and Network Management Kit, Volume 6 | Reference Pages Section 4: Special Files |
| | Reference Pages Section 5: File Formats |
| ULTRIX System and Network Management Kit, Volume 7 | Reference Pages Section 8: Maintenance |
| ULTRIX Software Development Kit, Volume 1 | Guide to Languages and Programming |
| | Guide to Developing International Software |
| | Guide to X/Open curses Screen Handling |
| | Guide to the Source Code Control System |
| | Guide to Preparing Software for Distribution on ULTRIX Systems |
| | The Packet Filter: An Efficient Mechanism for User-Level Network Code |
| | POSIX Conformance Document |
| ULTRIX Software Development Kit, Volume 2 | Guide to VAX C for ULTRIX |
| ULTRIX Software Development Kit, Volume 3 | Guide to Network Programming |
| | Guide to the X/Open Transport Interface |
| | DECrpc Programming Guide |
| | Guide to the Data Link Interface |

**Table 6-1: (continued)**

| Document Volume | Contents |
|---|---|
| ULTRIX Software Development Kit, Volume 4 | Reference Pages Section 2: System Calls |
| ULTRIX Software Development Kit, Volume 5 | Reference Pages Section 3: Library Routines |
| ULTRIX Supplementary Documents | Volume 1: General User |
| | Volume 2: Programmer |
| | Volume 3: System Manager |
| Compound Document Architecture Kit (optional product) | Introduction to the CDA Services |
| | Guide to Creating Compound Documents with the CDA Toolkit |
| | CDA Reference Manual |
| ULTRIX/SQL Kit, Volume 1 | ULTRIX/SQL NET User's Guide |
| | ULTRIX/SQL Database Administrator's Guide |
| | ULTRIX/SQL Operations Guide |
| ULTRIX/SQL Kit, Volume 2 | ULTRIX/SQL Reference Manual |

**Table 6-2: ULTRIX Worksystem Software Document Set**

| Document Volume | Contents |
|---|---|
| DECwindows User Information Kit, Volume 1 | Advanced Installation Guide |
| | Reader's Guide |
| | Introduction to the ULTRIX Worksystem Software Environment |
| | Reference Pages Sections 1X and 8X |
| | Reference Pages, Unsupported |
| DECwindows User Information Kit, Volume 2 | DECwindows User's Guide |
| | DECwindows Desktop Applications Guide |
| | Guide to the dxdiff Visual Differences Program |
| XUI Software Development Kit, Volume 1 | XUI Style Guide |
| | XUI Programming Overview |
| | Guide to Writing Applications using XUI Toolkit Widgets |
| | Guide to the XUI User Interface Language Compiler |
| | Guide to Porting Xlib Applications: X Version 10 to X Version 11 |
| | Guide to the dxdb Debugger |
| XUI Software Development Kit, Volume 2 | Guide to the XUI Toolkit: C Language Binding |

**Table 6-2: (continued)**

| Document Volume | Contents |
|---|---|
| XUI Software Development Kit, Volume 3 | Guide to the X Toolkit Widgets: C Language Binding |
| | Guide to the XUI Toolkit Intrinsics: C Language Binding |
| XUI Software Development Kit, Volume 4 | Guide to the Xlib Library: C Language Binding |
| XUI Software Development Kit, Volume 5 | X Window System Protocol: X Version 11 |
| XUI Software Development Kit, Volume 6 | Reference Pages Sections 3Dwt, 3X11, and 3Xt |
| XUI Software Development Kit, Volume 7 | Guide to Developing Display Applications for the Display PostScript System |
| | Display PostScript Perspective for Software Developers |
| | Display PostScript Client Library Reference Manual |
| | Extensions for the Display PostScript System |
| | Color Extensions for the Display PostScript System |
| | Display PostScript pswrap Reference manual |

See the *Reader's Guide and Master Index* in the appropriate document set for part numbers of individual documents and of orderable kits.

## 6.2 Online Documentation

The ULTRIX software provides extensive online documentation, including the entire contents of the ULTRIX Reference Pages. Table 6-3 describes the facilities that are available.

**Table 6-3: Online Documentation Facilities**

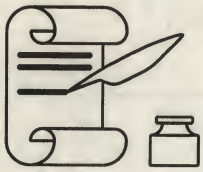
| Facility | Description |
|---|---|
| `man` | Uses `tbl`, `nroff`, and `col` to format and display manual pages. If `/usr/man/cat` *n* directories are present (see `catman`), uses `cat` instead for improved performance. |
| `catman` | Preformats manual pages for `/usr/man/cat` *n* directories, and creates the database used by `apropos` and `whatis`. |
| | Databases for `whatis` and `apropos` are created during base system installation. If you add any subsets that include manual pages, you must manually run `catman` to update the databases. |

**Table 6-3: (continued)**

| Facility | Description |
|---|---|
| `xman` (unsupported) | Improves the readability of online manual pages by creating a display that resembles a printed manual page. For use only on ULTRIX Worksystem Software systems. |
| `apropos` | Locates instances of referenced keywords in the manual pages. |
| `whatis` | Displays header lines from manual pages. |

In addition to the facilities described in Table 6-3, the DECwindows software provides a comprehensive online help facility. For most applications, help is available through a pull-down menu that leads to more specific help information. Some applications also provide context-sensitive help, displaying information for the window currently in use.

## 6.3 Documentation Development and Production



Much of the work performed with computers includes preparing documents for transmission in mail messages, presentation in reports, and other similar uses. Document preparation is supported in the ULTRIX environment by a broad set of tools.

Many of the tools listed in Chapter 2, such as `SCCS` and `awk`, are useful in the creation of both program source code and document files. In addition to these tools, the ULTRIX operating system provides editors and document processors, CDA (see section 6.3.3), and several unsupported tools.

### 6.3.1 Editors

The ULTRIX operating system provides the following editors:

- Interactive line editors (`ed` and `ex`)
- Stream editor (`sed`)
- Screen-oriented interactive editor (`vi`)
- Unsupported X Window System Version 11 editor (`xedit`) – optional with ULTRIX Worksystem Software
- Notepad-style editor (`dxnotepad`) – optional with ULTRIX Worksystem Software

The Digital versions of `ed`, `ex`, `sed`, and `vi` are enhanced to provide support for 8-bit files.

### 6.3.2 Processors and Formatters

The ULTRIX kit includes the common UNIX document formatting programs `nroff` and `troff`. (The `troff` formatter is unsupported.)

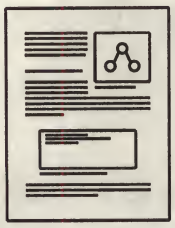
The optional ULTRIX Documentation Tools product includes most of the AT&T DOCUMENTER'S WORKBENCH tools and Digital-enhanced versions of the `troff` (`ditroff`) and `nroff` (`dinroff`) formatters, together with Digital's `mu` macro package and automated tools for creating indexes and tables of contents. Also provided in this optional product are a set of PostScript printing support utilities.

The additional utilities listed in Table 6-4 are included for special-purpose documentation needs.

**Table 6-4: Special-Purpose Documentation Tools**

| Utility | Function |
|---|---|
| `tbl` | Table formatting preprocessor |
| `eqn`, `neqn` (unsupported) | Equation formatting preprocessors |
| `-man`, `-me`, `-ms` | Formatting macro packages |

### 6.3.3 Compound Document Architecture



The Compound Document Architecture (CDA) provides a method for creating, storing, and interchanging files that contain a number of integrated components, including proportionally spaced text, synthetic graphics, scanned images, and external references to other CDA-compliant files that can be used as part of a given document. These compound documents can be edited, formatted, or otherwise processed as a document.

CDA defines formats and content of compound documents. The ULTRIX software supports the handling of compound documents with tools for manipulating, displaying, and transferring these files. Support includes provision for mailing compound documents through ordinary mail systems without the loss of content or formatting information.

Compound documents are stored in a format called the Digital Document Interchange Format (DDIF). Files can be translated between DDIF and other formats, such as ASCII text, with varying degrees of information loss. For example, ASCII files contain only text, with no implicit formatting information. Converting an ASCII file to a DDIF file retains all the information in the original file, but converting a DDIF file to ASCII produces a plain unformatted text file, with loss of any graphics or images in the original.

The ULTRIX operating system system provides facilities for manipulating and transporting compound document files, including:

- `dxvdoc`, a DECwindows application for viewing compound documents (part of the optional DECwindows environment provided by ULTRIX Worksystem Software)
- `vdoc`, a terminal-oriented application for viewing character-cell representations of compound documents
- `cdoc`, a tool for translating between DDIF and other formats
- `ctod` and `dtoc`, tools for translating between DDIF and Data Object Transport Format (DOTS), which allows transportation of compound documents by mail

### 6.3.4 Unsupported Tools

Various other document preparation tools are supplied with the ULTRIX operating system; among these are bibliographic tools and the GNU EMACS editor. As with `troff`, `eqn`, and so forth, these tools are not supported by Digital.

# Software Services 7

Digital provides a full range of software services for the ULTRIX operating system. The services described in this chapter are not necessarily available in all geographical areas. For complete information on the services provided by your area, contact your local Digital sales office.

Digital offers two types of support services:

- System startup service packages
- Support services

The following sections briefly describe these services.

## 7.1 System Startup Service Packages

System startup service packages are available with various levels of service. The services provided with these packages can include:

- Installation of the ULTRIX software

  Field Service installs the software on the Digital hardware at the customer's site.

- Training on the ULTRIX software

  Digital works with the customer to determine what training is needed and the most beneficial way to provide it. Topics covered can vary from how to use ULTRIX commands to ULTRIX system management.

## 7.2 Support Services

Digital provides a variety of ULTRIX support services, which can include:

- Telephone support

  Support is provided to resolve problems. If immediate solutions are not available, Digital provides workarounds until permanent solutions are found, escalating the problem severity as necessary.

- On-site remedial support

  If the Customer Support Center or remote resources cannot resolve a critical problem, then a specialist visits the site to determine the solution.

- Scheduled preventive maintenance

  An assigned specialist at Digital's Customer Support Center provides support, scheduling service delivery, performance reporting, and resolution of critical problems to maximize the availability of the software.

- Update Installation Service

  An assigned specialist at Digital's Customer Support Center provides pre-installation planning for each new release, installs the software, and verifies the installation.

- Access to software information and service delivery networks

  The Digital Software Information Network (DSIN) is a database maintained by Digital that contains descriptions of solutions to software problems. It is available by dialup connection.

- Software performance reports (SPRs)

  Customers can report ULTRIX software problems through SPRs. Every SPR receives a response, and solutions are entered into the DSIN database.

- DISPATCH

  The DISPATCH newsletter, which reviews solutions or workarounds to current SPRs, is available quarterly.

- Software media and documentation updates for each new release

  These updates are covered by a monthly charge and are distributed as kits.

# Licensing and Ordering Information Summary 8

For complete licensing and ordering information for the ULTRIX operating system, refer to the ULTRIX Software Product Description, available from any Digital sales office. The following list provides a brief summary of this information:

- A Single-Use License grants the right to use the software on a single CPU. When you purchase a Single-Use License for your first installation, you receive a distribution kit and documentation.
- A Right to Copy option allows a customer with multiple CPUs to copy a revised version of the software from one CPU to another.
- Source licenses are available.

**Note**

Kernels built from source code are not covered by Digital's support services.

- Educational discounts on binary licenses and source distributions are available.
- Digital's licensing agreement with AT&T requires login limits in the following increments: 2, 8, 16, 32, 64, or an unlimited number of users.

  The system considers a user to be an interactive login from a local terminal or a dialup port, or over the network. The system does not count printer ports and `tip` or `uucp` dialout lines as users.

Documentation is available separately. Support services are available from Digital (see Chapter 7). You can install the software yourself or purchase the Digital Installation Service.

# Software Subsets A

This appendix lists the software subsets that are supplied with the ULTRIX kit.

Table A-1 briefly describes the supported software subsets. Some of these subsets depend on the presence of others; refer to the ULTRIX installation documentation for specific dependencies.

**Table A-1: Supported Software Subsets**

| Subset | Description |
|---|---|
| Accounting Software | Programs and data files needed to perform system accounting. This subset contains log files that grow automatically. It is intended for users familiar with ULTRIX system administration. Optional. |
| Additional DECwindows Applications (Worksystem only) | Additional X11/DECwindows client applications that are optional on systems with sufficient disk resources. |
| Adobe Font Metric Files | Font metrics (character bounding box, width, name, ligature, kerning, and font properties) for PostScript outline fonts used by text formatting applications in PostScript output devices. Optional. |
| Base System | Fundamental utilities and data files for the ULTRIX operating system. The Base System includes the C compiler and linker, the editors, and all of the general-purpose programs. This subset is required and cannot be removed. |
| Bisynchronous Communications (VAX only) | Programs needed to use the 3780 and 2780 emulation features. Optional. |
| Communications Utilities | Utilities for several types of serial communications with other systems, including `tip`, `ftp`, and `telnet`. |
| DECwindows Server (Worksystem only) | X11/DECwindows server support. Required. |
| Diskless Support Environment | Software for a diskless environment. This subset is required only for diskless management services. |
| Document Preparation Software | The `nroff` text formatter with related data files, as well as utilities useful for producing documents. Optional. |
| Enhanced Security Features | Programs and data that provide enhanced security features. Optional. |
| Extended (Berkeley) Mailer | Programs and data that implement the BSD `sendmail` facility. |

**Table A-1: (continued)**

| Subset | Description |
|---|---|
| Internationalization Tools | Tools used for application program support of languages other than English. Optional. |
| Kerberos Network Authentication | Programs and data used to implement Kerberos network authentication. |
| Kernel Configuration Files | Utility programs and binary files required to configure ULTRIX kernels. This subset must be installed during installation but can be deleted afterwards. |
| Maintenance Operations Protocol | Software necessary to use your system as a boot server for Local Area Terminal devices such as the DECserver100. This subset also contains the `ris` utility, which lets you use your ULTRIX system as a server for network installations. Required for DMS. Optional otherwise. |
| Network File System Utilities | Programs and data files you need to share file systems over the network. This subset contains the files used to implement the Yellow Pages service. Optional. |
| Online Manual Pages | Online copies of the manual pages included in the ULTRIX Reference Pages. These manuals are stored in a language specific to the `nroff` text formatter. Optional. |
| Pascal Development Package (VAX only) | The Pascal language compiler and associated libraries and tools. Optional. |
| Printer Support Environment | Print services needed to use printers. These include `lpr`, `lpq`, `lpd`, and PostScript printer support. Optional. |
| RAND Mail Handler | Programs that constitute the Rand Corporation `MH` mail reader interface. Optional. |
| RPC Development Environment | Programs and data that implement the Remote Procedure Call (RPC) development environment. Optional. |
| RPC Runtime Environment | Programs and data that implement the Remote Procedure Call (RPC) runtime environment. Optional. |
| Software Development Utilities | Libraries and utilities useful for software development. These include the libraries for linking programs to be analyzed with the `dbx` debugger, the `lint` program verifier, and the `lex` and `yacc` parser packages. Optional. |
| Source Code Control System | Programs that make up the Source Code Control System. Optional. |
| System Exerciser Package | Programs that help in diagnosing problems with your VAX hardware and peripheral devices. Optional. |
| TCP/IP Networking Utilities | Programs and data used to implement Internet networking. Optional. |

**Table A-1: (continued)**

| Subset | Description |
|---|---|
| Unix-to-Unix Copy Facility | Programs and data files needed to let your system participate in a network of machines using the UNIX `uucp` facility to transmit files over serial communications lines. Optional. |
| UWS Reference Pages (Worksystem only) | Online manual pages for the programs and files contained in the X11/DECwindows windowing software. Optional. |
| VAX C Development Package | VAX C language compiler and associated libraries and tools. Optional. |
| VS35XX X11/DECwindows Fonts (Worksystem only) | Font files for VAXstation 3520 and 3540 systems. |
| VS35xx PostScript Previewer | PostScript Previewer for VAXstation 3520 and 3540 systems. Optional. |
| Worksystem Development Software (Worksystem only) | Library and data files needed to produce X Window System client applications. Includes example programs demonstrating how to get started. |
| X11/DECwindows 75 dpi Fonts (Worksystem only) | Fonts for X11/DECwindows. |
| X11/DECwindows 100dpi Fonts (Worksystem only) | Workstation font files for systems using the VR160 15-inch monitor or other monitors with higher resolution. |
| X11/DECwindows User Environment (Worksystem only) | X Window System client programs. Required. |

Table A-2 briefly describes the unsupported software subsets. Some of these subsets depend on the presence of others; refer to the ULTRIX installation documentation for specific dependencies. See Section B.1 for more information on unsupported software supplied with the ULTRIX operating system.

**Table A-2: Unsupported Software Subset Descriptions**

| Subset | Description |
|---|---|
| APL Development Package (VAX only) | User-contributed APL language interpreter and associated utilities. User-contributed software. |
| Auxiliary Command Line Interpreters | The "distributed" shell and a version of the C shell that features command completion. |
| Base Extension | Programs and data files that can be useful in some environments. These include obsolete boot programs, drivers for unsupported devices, the `troff` package with fonts, and miscellaneous software. |

**Table A-2: (continued)**

| Subset | Description |
|---|---|
| Bibliographic Utilities | Programs and data useful in maintaining bibliographic information. User-contributed software. |
| Computer-Aided System Tutor | Software for the `learn` program, which provides lessons in aspects of the computing environment. This subset is useful for persons new to the UNIX environment. |
| CP/M 8in Diskette Utility (VAX only) | Utilities for reading and writing 8-inch diskettes used with the CP/M operating system. |
| Franz Lisp Development Package (VAX only) | Programs that make up the Franz Lisp program development environment, including interpreter, libraries, and compiler. |
| Games and Diversions | Programs used for entertainment. |
| GNU EMACS | The public-domain GNU EMACS editor and edit-macro files. |
| Hyperchannel Utilities (VAX only) | The Hyperchannel driver and associated daemons and utilities. |
| ICON (Language) Development Package (VAX only) | Translator and linker for the ICON programming language. |
| Miscellaneous User-Contributed Utilities | Small utilities contributed by the user community. |
| Modula-2 Development Package (VAX only) | Modula-2 compiler and libraries. |
| Notesfiles Package | Software that lets you establish notesfiles on your ULTRIX system. |
| Remote Procedure Call Compiler | Modules for producing software using the COURIER remote procedure call protocol. |
| Revision Control System | Programs that make up a package similar to the SCCS facility provided with the supported software subsets. |
| Software Project Management System (VAX only) | A package useful for managing large software development efforts. |
| Supplementary Documentation | Online copies of ULTRIX Supplementary Documentation. |
| University Ingres QUEL DBMS (VAX only) | University INGRES QUEL database management system. |
| Unsupported FORTRAN Utilities (VAX only) | Utilities for developing programs using the UNIX `f77` dialect of FORTRAN. |
| Unsupported Manual Pages | Online reference pages for unsupported X11 features. |
| Unsupported Online Manuals | Online manual pages for programs found in the Base Extension subset. |

**Table A-2: (continued)**

| Subset | Description |
|---|---|
| Unsupported X11 Components | Programs and fonts for the X Window System protocol level 11. Contains applications such as `xterm`, `xload`, and `xedit`. |
| USENET News Interface Software | Software needed to participate in the USENET news network. |
| X10 to X11 Compatibility Tools | Unsupported tools to help the migration from X Window System protocol level 10 to protocol level 11. |

# Unsupported Software B

The ULTRIX operating system is enhanced by a variety of unsupported software. The term **unsupported** means that Digital does not test the software and does not warrant its function, performance, or reliability, nor does Digital commit to correct problems found in it or to develop or upgrade it.

ULTRIX unsupported software comes from two primary sources:

- Software included with the ULTRIX operating system
- Software available through DECUS

## B.1 Software Included with the ULTRIX Operating System

The unsupported software that is supplied as part of the ULTRIX software package can be divided into two types:

- General programs

  These programs consist of tools and utilities developed at Berkeley and by other users of UNIX systems that have become part of the accepted UNIX environment.

- Specialized tools

  These programs consist largely of drivers and utilities developed to support specific hardware configurations and devices. Some of this hardware is made by Digital, and some is supplied by other system vendors.

The software components listed in Table B-1 are included with the ULTRIX operating system but are not currently supported by Digital. This software is supplied in the unsupported subsets listed in Table A-2.

**Table B-1: Unsupported Software Components**

| Commands | |
|---|---|
| **Component** | **Description** |
| `as` | VAX/UNIX assembler |
| `diff` | VAX/UNIX file comparing utility |
| `efl` | Extended FORTRAN language |
| `eqn` | Mathematics typesetting preprocessor |
| `f77` | Berkeley FORTRAN 77 compiler |
| `fed` | Font editor for HP 2648 terminal |
| `fp` | Functional Programming Language compiler/interpreter |
| `fpr` | Print FORTRAN file |
| `help` | Tips on getting started with the ULTRIX system |

**Table B-1: (continued)**

## Commands

| Component | Description |
|---|---|
| learn | Computer-aided instruction about the ULTRIX system |
| lisp (VAX only) | Lisp interpreter |
| liszt (VAX only) | Franz Lisp compiler |
| lxref (VAX only) | Lisp cross reference program |
| mod (VAX only) | Modula-2 compiler |
| msgs | System messages and junk mail program |
| pti | C/A/T phototypesetter interface |
| ptoc | Pascal-to-C language translator |
| ratfor | Rational FORTRAN dialect |
| rcs | Revision Control System (similar to SCCS) |
| struct | Structure FORTRAN programs |
| sysline | Display system status on status line of a terminal |
| tc | Graphic Systems typesetter simulator for Tektronix 4015 |
| tk | Paginator for Tektronix 4014 |
| tp | Manipulator for tape archives |
| trman | Translator for V6 manual-formatting macros to V7 |
| troff | Text formatter |
| units | Unit conversion program |
| vfontinfo (VAX only) | Inspection and information display for UNIX fonts |
| vgrind | Program listing formatter |
| vlp (VAX only) | Lisp formatter for typeset printing |
| vpr | Raster printer/plotter spooler |
| vtroff | Text formatter for raster plotter |
| vwidth (VAX only) | Font table-width generator |

## Special Library Functions

| Component | Description |
|---|---|
| lib2648 | Subroutines for HP 2648 terminal |

## Special Files

| Component | Description |
|---|---|
| acc (VAX only) | ACC LH/DH IMP interfaces |
| ad (VAX only) | Data Translation A/D converter |
| bk (VAX only) | Line discipline for intersystem communication (obsolete) |
| css (VAX only) | DEC IMP-11A LH/DH IMP Interface |
| ct (VAX only) | C/A/T phototypesetter interface |
| dh | DH-11/DM-11 Communications multiplexer |
| dn (VAX only) | DN-11 autocall unit interface |
| ec (VAX only) | 3Com 10Mb/s Ethernet interface |
| en (VAX only) | Xerox 3Mb/s Ethernet interface |
| hy (VAX only) | Network Systems Hyperchannel interface |
| ik (VAX only) | Ikonas frame buffer, graphics device interface |
| il (VAX only) | Interlan 10Mb/s Ethernet interface |
| imp (VAX only) | 1822 network interface |

**Table B-1: (continued)**

**Special Files**

| Component | Description |
|---|---|
| kg (VAX only) | LK-11/DL-11w line clock |
| lpv | LPV11 parallel line printer |
| pcl (VAX only) | Digital CSS PCL-11 B network interface |
| ps (VAX only) | Evans and Sutherland Picture System 2 device interface |
| pup (VAX only) | Xerox PIP-I protocol family |
| tm (VAX only) | TM/11/TE-10 magnetic tape interface |
| un (VAX only) | Ungermann-Bass interface |
| up (VAX only) | Unibus storage module controller/driver |
| urx (VAX only) | Digital RX02 floppy disk interface |
| ut (VAX only) | Unibus TU45 tape drive interface |
| uu (VAX only) | TU58/DECtape II interface |
| va (VAX only) | Benson-Varian interface |
| vp (VAX only) | Versatec printer/plotter interface |
| vv (VAX only) | Proteon proNET 10 Mb/s ring interface |

**Macro Packages**

| Component | Description |
|---|---|
| eqnchar | Special character definitions for eqn |

**Maintenance Tools**

| Component | Description |
|---|---|
| rdt | Reader for diagnostic tapes written by a VMS system |

## B.2 Software Available Through DECUS

The Digital Equipment Computer Users' Society (DECUS) is an independent nonprofit organization. DECUS maintains a large library of contributed software for all of Digital's operating systems, including the ULTRIX operating system. DECUS software is not warranted by Digital.

# POSIX FIPS 151-1 Modifications C

This appendix lists Federal Information Processing Standard (FIPS) modifications to the IEEE 1003.1-1988 (POSIX) standard, as published in the Federal Register. These modifications are required in implementations to be procured by United States federal agencies. The ULTRIX operating system conforms to these requirements; see Digital's *POSIX 1003.1 Conformance Document*. Items in the following list are keyed by letter to the list in the Federal Register.

a. Inconsistencies with CLK_TCK exist between the IEEE Std 1003.1-1988 and the referenced ANSI/X3.159-1989 Programming Language C Standard draft 13 May 1988 (X3J11/88-002). This inconsistency shall be resolved in the ratified C Standard. Until the C Standard is ratified, CLK_TCK is to be treated as a POSIX-only symbol.

b. The implementation shall support the option _POSIX_CHOWN_RESTRICTED.

c. The implementation shall support the option {NGROUPS_MAX} such that the value of {NGROUPS_MAX} is greater than or equal to eight (8).

d. The implementation shall support the setting of the group-ID of a file (when it is created) to that of its parent directory.

e. The implementation shall support the functionality associated with the feature {_POSIX_SAVED_IDS}.

f. The implementation shall support the functionality associated with the feature {_POSIX_VDISABLE}.

g. The implementation shall support the option _POSIX_JOB_CONTROL.

h. The implementation shall support the functionality associated with the feature {_POSIX_NO_TRUNC}.

i. In section 6.4.1.2, the sentence "If a `read()` is interrupted by a signal after it has successfully read some data, either it shall return -1 with *errno* set to [EINTR], or it shall return the number of bytes read." shall be deleted and replaced with the sentence "If a `read()` is interrupted by a signal after it has successfully read some data, it shall return the number of bytes the system has read."

   In section 6.4.2.2, the sentence "If a `write()` is interrupted by a signal after it successfully writes some data, either it shall return -1 with *errno* set to [EINTR], or it shall return the number of bytes written." shall be deleted and replaced with the sentence "If a `write()` is interrupted by a signal after it successfully writes some data, it shall return the number of bytes the system has written."

j. The environment for the login shell shall contain the environment variables HOME and LOGNAME as defined in section 2.7.

# Index


## A

**addition**
of software by users, 2–10 to 2–11
**administration**
*See* system administration
**ALL-IN-1**
mail access to, 3–4
**ANSI**
tape format, 2–9
**Apple systems**, 2–2
**ASCII text files**, 6–6
**authentication, network**, 3–5

## B

**Berkeley Internet Name Domain**, 3–2, 4–5
**Berkeley Standard Distribution**, 1–1
ULTRIX compatibility with, 4–5
**BIND service**
*See* Berkeley Internet Name Domain
**Bourne shell**
*See* shells
**BSD**, 1–1
**BSD mail facility**
*See* mail

## C

**C shell**
*See* shells
**CDA**
*See* Compound Document Architecture
**CDROM support**, 5–2
**CI**, 1–2, 2–8
**command languages**
*See* shells
**commands**, 1–2
unsupported, list of, B–1t
**Common Applications Environment**, 4–3
**Compatibility with industry standards**, 4–1 to 4–7
**compatibility with other UNIX systems**, 4–1 to 4–7
**compliance**
defined, 4–1
**components**, 1–1
**components of ULTRIX**, 1–1f
**Compound Document Architecture**, 2–5, 6–6 to 6–7
**compound documents**, 6–6
**Computer Interconnect**, 1–2
**configuration, system**
*See* system configuration
**conformance**
defined, 4–1
**console terminal**
*See* Terminals, console, requirements
**crash dumps**, 2–10

## D

**DDIF**
*See* Digital Document Interchange Format
**debuggers**
*See* tools, software development
**DECnet**
*See* network access, DECnet
architecture, 3–2
**DECserver**, 3–5
**DECstation**
*See* Workstations

**DECwindows**
applications, bundled, 2–7, 2–2, 2–6, 6–5
**derivation of ULTRIX**, 1–2f
**Digital Document Interchange Format**, 6–6
**disks**
media interchangeability with UNIX V7, 4–7
media requirements, 5–3
MSCP, 5–2
SCSI, 5–2
support for, 2–10
system, requirements for, 5–2
Unibus, 5–2
**Display PostScript**, 2–7
**distribution kit**
*See* installation, distribution kit
**document processors and formatters**, 6–6
**document set**
*See* ULTRIX document set
**documentation**, 6–1 to 6–7
development and production, 6–5
**drivers, terminal**
*See* terminals, drivers for
**dxnotepad editor**, 6–5

## E

**editors**, 6–5
**encryption and decryption**, 4–7
**enhancements**, 1–2
**errors**
disk, 5–3
logging and reporting, 2–10
recovery from, 2–10
**exporting files under NFS**, 3–3

## F

**facilities**
networking, 3–1 to 3–5
software development, 2–3 to 2–7
system, 2–1 to 2–11
**features**, 1–2
**Federal Information Processing Standard**, 4–2, C–1
**file archiving**
*See* tools, archiving
**file sharing**
NFS, 3–3
with VMS, 3–3
**file system**, 1–2
formats, 4–5, 4–7
generic, 1–2
**files**
unsupported, list of, B–1t
**filters, printer**
*See* printers, filters for
**FIPS**
*See* Federal Information Processing Standard

## G

**G protocol for uucp access**, 3–5
**general use**
defined, 2–1
**generation, system**
*See* system generation
**GKS**
*See* Graphical Kernel System
**Graphic Kernel System**, 2–7
**graphics**, 2–7

## H

**hardware requirements**, 5–1 to 5–3
**Hierarchical Storage Subsystem**, 1–2
**HSC**, 1–2, 2–8

## I

**IBM systems**, 2–2
mail access to, 3–4
**IEEE Standard 1003.1**
*See also* POSIX, 4–2
**importing files under NFS**, 3–3
**industry standards**
*See* compatibility with industry standards
**installation**
distribution kit, 2–7

**installation** (cont.)
of software, 2–7 to 2–8
by Digital, 7–1
remote, 2–8
**installation media**
*See* system load media
**Internet**
*See* network access, Internet
**I/O**, 1–2

## K

**Kerberos authentication**, 3–5
**Korn shell**
*See* shells

## L

**languages**
adding other, 2–4
C, 2–3, 4–5
FORTRAN, 2–3
Lisp, 2–4t
Modula-2, 2–4t
Pascal, 2–4t
programming, 2–3 to 2–4, 2–4t
unsupported, 2–4
VAX C, 2–3
VAX FORTRAN, 2–3
VAX Lisp, 2–4t
**LAT**
*See* Local Area Transport
**licensing**, 8–1
**limits**
number of users, 8–1
**line printers**
*See* printers
**linkers**
*See* tools, software development
**loaders**
*See* tools, software development
**Local Area Transport**, 3–5
**login limits**
*See* limits, number of users

## M

**magnetic tape support**, 5–2
**mail**, 3–4
**maintainability**, 2–10
**manuals**, 6–1
**Mass Storage Control Protocol**, 5–2
**memory requirements**, 5–1
**MH mail system**
*See* mail
**MicroVAX processor support**, 5–1
**minimum hardware configuration**, 5–1f
**modification, system**
*See* system modification

## N

**native software**, 1–1
**network access**
DECnet, 3–2
commands, 3–2
facilities, 3–2
file transfer, wildcards in, 3–2
Internet, 3–1
commands, 3–1
protocols, 3–1
NFS, 32
functions, 3–3
uucp, 3–5
functions, 3–5
virtual terminal, 3–5
VMS/ULTRIX Connection, 3–3
**network authentication**, 3–5
**Network File System**
*See* network access, NFS, 4–5
**network transparency**, 2–2
**newsletters**, 7–2
**NFS**
*See* network access, NFS
**NIST**, 4–2t

## O

**online documentation**, 6–4
facilities, 6–4t
**open software environments**, 4–1, 4–1t
**Open Software Foundation**, 4–2t, 4–4
ULTRIX conformance with, 4–4t
**organization of ULTRIX**, 1–1
**OSF**
*See* Open Software Foundation

## P

**PC**
*See* personal computers
**personal computers**
integration with, 2–2
**plotting**, 2–7
**portability**
of applications between UNIX systems, 4–1, 1–2
languages, 2–3
shells, 2–3
source level, SYSTEM V, 4–5
windowing applications, 2–5
windowing environment, 2–2
**POSIX**, 4–2, 4–2t
conformance test suite, 4–2
FIPS modifications, C–1
ULTRIX conformance with, 4–2
USTAR tape format, 2–9
**POSIX 1003.1 Conformance Document**, 4–2
**PostScript**
*See* Display PostScript
*See* printers, PostScript, 6–6
**printcap database**, 2–2
**printers**, 2–2 to 2–3
control and monitoring, 2–2 to 2–3, 2–8
differing capabilities, 2–2
filters for, 2–2
PostScript, 2–2
serial, connecting to DECserver, 3–5
unfiltered access, 2–2
**problem resolution**, 7–2
**processor support**, 5–1
**programming languages**
*See* languages, programming

## R

**reference pages**, 6–4
**related documentation**, viii
**remote distribution service**, 2–9
**RISC processors**, 5–1
**RMS files**, 3–3
**root file storage**, 5–2

## S

**server**
kit installation, 2–10
**services**
*See* facilities
**services, software**, 7–1 to 7–2
**shells**, 2–1, 2–3, 4–5, 4–7
purpose and description of, 2–3
**Simple Network Management Protocol**, 3–2
**SMP**
*See* symmetrical multiprocessing
**SNMP**, 3–2
**software**
addition of by users, 2–10 to 2–11
**software load device**, 5–2
**Software Product Description**, viii, 5–1, 5–2
**software services**
*See* services, software
**SPD**
*See* Software Product Description
**spoolers**, 2–1
**SQL**, 2–5
**subsets**, 2–7, 2–10
optional, storage, 5–2
supported, list of, A–1t
unsupported, list of, A–3t
**subsystems**, 1–2
**support services**, 7–1
**SVID**
*See* SYSTEM V, interface description

**SVID** (cont.)
*See* System V, ULTRIX compatibility with
**swap space requirements**, 5–2
**symmetrical multiprocessing**, 1–2
tools for controlling, 2–9
**system administration**, 2–8 to 2–9
**system configuration**, 2–8
**system disk requirements**
*See* disks, system, requirements for
**system generation**, 2–8
**system load media**, 2–8
**system management**, 2–7 to 2–10
**system modification**, 2–8
**System V**
administered system extension, 4–6
advanced utilities extension, 4–6, 1–1
**SYSTEM V**, 1–2
**System V**
ULTRIX compatibility with, 4–5
compatibility, 4–5t
**SYSTEM V**
interface description, 2–2
**System V**
software development extensions, 4–6
**SYSTEM V shell**
*See* shells
**system verification**, 2–8

## T

**Telex**
mail access to, 3–4
**termcap database**, 2–2
**terminal concentrators**
*See* Local Area Transport
**terminals**, 2–1, 2–2
character cell, 2–2
console, requirements, 5–2
differing capabilities, 2–2
drivers for, 2–2
**tools**
archiving, 2–9
media support, 2–9
compound document handling, 6–6
**tools** (cont.)
document preparation, 6–5, 6–6
special-purpose, 6–6
unsupported, 6–7
file system, 2–8
image building, 2–5
object control, 2–5
printer control, 2–8
software development, 2–3, 2–4
software installation, 2–7, 2–10
software kit building, 2–10
software maintenance, 2–3, 2–5
source control, 2–5
system administration, 2–8 to 2–9
operator service, 2–8
system maintenance, 2–10
system management, 2–7 to 2–10
system monitoring, 2–9
unsupported, list of, B–1t
**training**, 7–1

## U

**ULTRIX**
description of, 1–2
native software, 1–1
**ULTRIX, derivation of**, 1–1
**ULTRIX components**, 1–1
**ULTRIX document set**, 6–1, 6–1t
**ULTRIX organization**, 1–1
**ULTRIX Software Source Book**, 2–4
**ULTRIX Worksystem Software**, 2–2
features, 2–6
programming, 2–5 to 2–7
server and diskless workstations, 2–2
**UNIX V7**
ULTRIX compatibility with, 4–7
plot library, 2–7
**user**
defined for licensing, 8–1
**user guides**, 6–1
**user interfaces**, 2–1
**user login limits**
*See* limits, number of users

**/usr file storage**, 5–2
**uucp**
*See* network access, uucp

## V

**VAX C language**
*See* languages, VAX C
**VAX FORTRAN language**
*See* languages, VAX FORTRAN
**VAX processors**, 1–2, 5–1
**VAXBI**, 1–2
**VAXserver processor support**, 5–1
**VAXstation**
*See* Workstations
**VAXstation processor support**, 5–1
**verification, system**
*See* system verification
**vi editor**, 6–5
**VMS**, 2–2
**VMS/ULTRIX Connection**
*See* network access, VMS/ULTRIX Connection

## W

**workstations**, 2–1, 2–2
color, 2–2
diskless, 2–2
monochrome, 2–2

## X

**X server**
*See also* xerver, 2–2, 2–6
VAX, 2–2
**X User Interface**
*See* XUI, 2–5 to 2–7
**X Window System**, 2–2, 2–5 to 2–7
enhancement in DECwindows, 2–2
**X.400 networks**
mail access to, 3–4
**xedit editor**, 6–5
**X/Open**, 4–2t, 4–3
ULTRIX conformance with, 4–3t
**X/Open Portability Guide**, 4–3
**XPG2**
*See* X/Open Portability Guide
**XPG3**
*See* X/Open Portability Guide
**XUI**, 2–6
Toolkit, 2–6

## Y

**Yellow Pages service**, 32, 3–3

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